Chapter 13

Tasha Henderson: Acoustical Engineering

S.T.E.M teacher for Chicago Public Schools. Tasha Henderson is a life-long learner and has a deep passion for the sciences and technology. Prior to her career in education she was a Senior Database Administrator for the Chicago Board of Trade for several years. She is a Chicago native and enjoys the downtown scenery and summer festivals. In her spare time she loves spending time with her family and attending events in theater, dance and music.

Acoustical Engineering: Representing Sound using Technology

Grade Level: Grades 3-5

Content Area Topic: Acoustical Engineering

Content Area Standard(s):
CCSS: RI.3.1, RI.3.2, RI.3.3

NGSS:
- 3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

NGSS Disciplinary Core Ideas:
- ETS1.A: Defining and Delimiting Engineering Problems: Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1)
- ETS1.B: Developing Possible Solutions: Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
- At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)
- Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3)
- ETS1.C: Optimizing the Design Solution: Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)

Common Core State Standards Connections:: ELA/Literacy -

- RI.5.1: Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (3-5-ETS1-2)
- RI.5.9: Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (3-5-ETS1-2)
- W.5.7: Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (3-5-ETS1-1), (3-5-ETS1-3)
- W.5.8: Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (3-5-ETS1-1), (3-5-ETS1-3)
- W.5.9: Draw evidence from literary or informational texts to support analysis, reflection, and research. (3-5-ETS1-1), (3-5-ETS1-3)

Mathematics

- 3.OA: Operations and Algebraic Thinking (3-ETS1-1),(3-ETS1-2)
- MP.2: Reason abstractly and quantitatively. (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)
- MP.4: Model with mathematics. (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)
- MP.5: Use appropriate tools strategically. (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)
- 3-5.OA: Operations and Algebraic Thinking (3-ETS1-1),(3-ETS1-2)

Engineering Design Process used throughout the Acoustical Engineering Unit.

Learning Objective(s):
Key Learning Points:
- Scientists and engineers often use representation of sound to study and communicate about them.
- There are many different ways to represent the same sound.
- Sounds are comprised of several different properties that can be expressed in various ways.
- Using representation systems are a type of technology.

Rationale:
- Work collaboratively to design a representation system for communicating the properties of sound using virtual instruments.
- Use the Engineering Design Process to creatively design and construct a new sound and musical track.

SWBAT:
- Demonstrate that there are various ways to represent the same or different sounds.
- Evaluate: Ask, Imagine, Plan, Create, and Improve steps from Engineering Design Process to design and create their Garage Band Track representations.
- Articulate and explain with their partner presentations for their Garage Band Tracks

*Suggested Time Allotment:*1-2 sessions; 60 minutes

Sequence in Learning:
Geography was used as an introduction to the Unit on drumming and how it's used in Africa as a means of communication.
Prior to this lesson students have studied the Engineering Design Process in detail. Students have also learned the Acoustical Engineering occupation and visual representation of animal sounds. Following this lesson students will have a deeper understanding of using computer technology to compose a composition for their own song.

Materials & Resources Needed:
- www.pbslearningmedia.org
- MacBook Air Laptops
- Garage Band
- Do Now sheets
- Exit Tickets
- Assignment Task Card
- Garage Band Laboratory Sheets

Lesson Activities & Sequence:
Students will: 5-7 minutes

DO Now: Considering we have been learning and creating various representations for sounds using our handmade materials. Can we use computer technology to create various representations of sound? Explain your answer.
Teacher: Play the Acoustics video: "STEM Careers Acoustics Professor"
Teacher: Explain, what does a representation system for sound means as seen in the video?

Teacher will: 10 minutes
Review Do now answers with students and discuss their answers. After responses have been discussed teacher will introduce Garage Band application as another tool that can be used to represent sound virtually. Teacher will review the definition of technology and how technology is used. "Technology is almost anything created to solve a problem or meet a need."

Teacher and Students will: 5 minutes
Teacher will scaffold the Garage Band application and guide students through the process to create a track and the various functions of the instruments. Explain the assignment expectation and pass out laboratory sheets and MacBook Air laptops.

Students will: 25 minutes
In differentiated groups with heterogeneous groupings students will have team roles previously assigned. Diverse Learners will receive Form B and Tier 1 & Tier 2 will receive Form A.
Students will work collaboratively with partners to design and construct their tracks using Garage Band application.
Teacher will:
Did we use computer technology for a representation system? How did we you use it?

Lesson Review & Exit Ticket: 5 minutes
Students will: Complete exit ticket question: How did the design and creation of your Garage Band track go? Do you plan to make improvements?

Proficiency:
In order for the students to reach proficiency or mastery students must answer question 4 and question 5 with a thorough knowledge of the connection of: How would an Acoustical Engineer use the Garage Band application in their occupation?
Laboratory sheets will be graded using a point value for each laboratory question and the Engineering Design Process. Total point is 16.

Feedback

Teachers As Learners:
Educator must be knowledgeable on using the Garage Band Application and use strategies to address the multiple intelligences through-out in the laboratory activity. Lesson made connections to all learners such as visual, tactile, kinesthetic, and definitely auditory. The visual representation of sound were all represented using this software. The activity was multi-sensory on all levels.

Connections made across various content areas was explored through-out the lesson. During the lesson teacher and students examined the Spectrogram and Waveforms in the application. This task includes discussing mathematics such as duration and positioning of the pitches.

There is an abundance of hands-on, interactive, lots of exploration, no barriers to their creativity and exploring. Good classroom management is essential to get students disciplined enough to stop using the application and transition to the next task. Procedures and routines need to be in place so every student has the same opportunity to use the design and test with the application. Prior lessons will strongly equip students with adequate prior knowledge to prepare for participation in the Garage Band activity.

Elements of Pretty Good Practice:
- Pedagogical strategies that made this lesson a success:
- Scaffold the use of the Garage Band Application
- Higher-Order and Critical thinking Activities through-out lesson
- Activating prior knowledge
- Cross-curricular laboratory tasks
- Directive instruction is characterized by a computer-based tutorial where information is presented, the student responds, feedback is provided and this tutorial learning cycle is repeated.
- Guided Discovery is characterized by a Garage Band simulation that allowed the students to manipulate the application or environment.
- Exploratory instruction is characterized by an open learning environment in which the students was provided a rich, networked database of information, examples, demonstrations, and exercises from which the student can select whatever is appropriate to their current needs and mental models.

Modifications and Adaptations:
Create extended learning tasks for enrichment students – create full song with more instruments.

Questions Arisen:
- How can this activity work as a "center" activity if your classroom does not have technology for every student or pair of students?
- How can we get a technology device for every student?

Peer Feedback:
Maybe extend classroom learning to visiting a live performance or recording music studio or other venues where acoustical design/ engineering is a key element

Bibliography:
Martin, Jeannette, and Braden Chang. Sounds like Fun: Seeing Animal Sounds: Sound and Acoustical Engineering for Elementary Students. Boston: Museum of Science, 2006.

PBSLearning Media Video. PBS. 1990. The Pennsylvania State University. 1990 Video Streaming.

Related Resources/Ideas:
Attached:
- Garage Band Laboratory Sheet
- Garage Band Task Card
- Do Now Sheet/ Exit Ticket

NAME_____

DATE_____ Room_____

*** Please complete your lab sheet using complete sentences. *** Remember: Acoustical Engineers design many different technologies and systems having to do with sound.

1. What type of music did you and you partner select? Explain why the two of you selected this type of music? Worth 2pts

2. Do you hear certain instruments in the music you have selected? What are they? Worth 3pts

3. List at least 5 different instruments that are listed in your Garage Band application?

Worth 5 pts

1. _____
2. _____
3. _____
4. _____
5. _____

4. How might an Acoustical Engineer use the Garage Band application to perform their job? Why? Worth 2pts

5. How would an Acoustical Engineer use the Engineering Design Process with the Garage Band application? Explain. Worth 2pts

6. Sketch a drawing of your favorite instrument used in the Garage Band application. Worth 2pts

NAME_____
DATE_____ Room_____
*** Please complete your lab sheet using complete sentences. ***
Remember: Acoustical Engineers design many different technologies and systems having to do with sound.
What type of music did you and you partner select? Explain why the two of you selected this type of music? Worth 2pts

Do you hear certain instruments in the music you have selected? What are they? Worth 3pts

3. List at least 5 different instruments that are listed in your Garage Band application?
Worth 5 pts
1. _____
2. _____
3. _____
4. _____
5. _____
6. Sketch a drawing of your favorite instrument used in the Garage Band application. Worth 2pts

NAME_____ DATE_____

Logon to Garage Band

Select New Project

Create your own File

Select Loops

Create your own beats by clicking and dragging selected instruments

USE COMPLETE SENTENCES

What instruments did you select?

Explain why did you choose these instruments?

What did you do to improve the sound of your track? Explain

4. How would an acoustical engineer use the Loop options for Garage Band? Use the back side